REMARKS

Reconsideration of the June 5, 2003 Official Action is respectfully requested.

The only issue raised in the Official Action is the rejection of Claims 1-23 under 35 USC §103(a) as allegedly being unpatentable over U.S. Patent No. 6,380,096 ("Hung") in view of U.S. Patent No. 6,362,109 ("Kim"). The reasons for the rejection are set forth in paragraph 6, on pages 2-6 of the Official Action. This rejection is respectfully traversed for the following reasons.

Claim 1 sets forth a process for etching a silicon nitride layer with selectivity to an underlying and/or overlying dielectric layer, comprising introducing a semiconductor substrate into a medium density plasma etching reactor, the semiconductor substrate having a layer of silicon nitride and the layer of silicon nitride having an underlying and/or overlying dielectric layer; supplying etching gas to the plasma etching reactor and energizing the etching gas into a plasma state, the etching gas including CH_3F and at least one oxygen reactant supplied to the plasma etching reactor at a flow rate ratio of oxygen reactant to CH_3F of 0.65 to 1.5; etching exposed portions of the silicon nitride layer with the plasma so as to etch openings in the silicon nitride layer with the plasma while providing an etch rate selectivity of the etching rate of the silicon nitride layer to the etching rate of the dielectric layer of at least about 10. The combinations of features recited in Claim 1 and in the claims dependent thereon are not suggested by the combination of Hung and Kim.

In the Official Action, Hung is cited for a disclosure of a method of plasma etching a silicon nitride layer using an etching gas including at least one fluorocarbon reactant and at least one oxygen reactant supplied to the plasma etching reactor at a flow rate ratio of oxygen reactant to fluorocarbon reactant of 1.5 or less (paragraph bridging pages 2-3 of Official Action). The Official Action refers to Tables 6 and 7 of Hung for disclosure of an etching gas which is nitrogen-free and wherein the flow rate ratio of oxygen reactant to fluorocarbon reactant is 1 or less, i.e., 10 sccm O_2 and 10 sccm CH_2F_2 in Table 6 and 5 sccm O_2 and 30 sccm CH_3F in Table 7 (Official Action at page 4). Table 7 of Hung is cited for a disclosure of an etching gas consisting essentially of CH_3F, oxygen and optionally argon as a carrier gas (Official Action at page 4). However, Hung teaches away from the claimed process as explained below.

As pointed out in previous responses, the nitride etch of Hung is carried out in a high-density plasma etcher. In addition to this substantial difference between the claimed method and the nitride etch disclosed in Hung, Hung teaches away from using the claimed gas flow ratio as illustrated by the following excerpts from Hung:

> "The nitride removal using CH_2F_2 is insufficiently selective to oxide and tends to remove some of the lower oxide layer beneath the trench. According [sic] a variant has been developed using the more heavily polymerizing monoflouromethane (CH_3F) as the principal fluorocarbon in the nitride removal 146." (Column 12, lines 41-46 of Hung).

> "The very heavy polymerization of CH_3F eliminates any observable nitride undercutting. The further reduction in bias power yet further protects against copper sputtering. Further window experiments were conducted. The general conclusions are that increased CH_3F flow decreases the undercutting and increases the selectivity to oxide. On the

> other hand, increased O_2 flow greatly increases the undercutting and reduces the selectivity to oxide." (Column 12, lines 60-67 of Hung).

Hung teaches away from the process recited in Claim 1. The above excerpts of Hung indicate that increased CH_3F relative to O_2 flow rates are needed to obtain a desired etching rate of the silicon nitride layer relative to the etching rate of the dielectric layer. In the example given in Table 7 of Hung, the flow rate ratio of oxygen reactant to CH_3F is 5:30 which equals 0.16 and the process is carried out in a high density plasma etching reactor. According to the process recited in Claim 1, the flow rate ratio of oxygen reactant to CH_3F is 0.65 to 1.5 and the process is carried out in a medium density plasma etching reactor. Because Hung uses a high density plasma and teaches away from increasing the oxygen flow rate with respect to the CH_3F flow rate as indicated in the above excerpts, Claim 1 and the claims dependent thereon are clearly patentable over Hung taken alone or in combination with Kim.

As explained above, Hung teaches the use of increased CH_3F flow compared to O_2 flow in order to decrease undercutting and increase the selectivity to oxide (see column 12, lines 60-67 of Hung). The effect on the increase in CH_3F flow rate in the high density reactor disclosed in Hung is contrary to the result observed according to the claimed process. That is, according to the process recited in Claim 1, it is possible to obtain high selectivity of the etching rate of silicon nitride to the etching rate of dielectric material by increasing the O_2 flow rate relative to the CH_3F flow rate. Such a result is unexpected in view of the disclosure of Hung. Accordingly, it is submitted that Claim 1 and the claims

dependent thereon are clearly patentable over Hung taken alone or in combination with Kim.

In the Official Action, Kim is cited for a method of etching silicon nitride in a medium density plasma reactor and it is alleged that "it would have been obvious to one of ordinary skill in the art at the time of the invention was made to etch the silicon oxide layer and the silicon nitride layer as taught by Kim et al. in the plasma etching process of Hung et al. . . ." (paragraph bridging pages 3-4 of Official Action). However, as explained above, the nitride etch disclosed by Hung behaves in a contrary manner than the claimed process since the Hung process is carried out in a high density plasma reactor. Accordingly, high and medium density plasma reactors are not interchangeable in the process of Hung. As such, it is submitted that a person of ordinary skill in the art would not have considered using a medium density plasma reactor for the nitride etch of Hung. Moreover, because Hung seeks to carry out a multiple step etch in the high density plasma reactor because the high density plasma provides the selectivity and process flexibility required to satisfy the conflicting requirements of the many steps (see column 3, lines 23-37 of Hung), a medium density plasma reactor clearly would be unsuitable for such multi-step processing of Hung. Accordingly, it is submitted that a person of ordinary skill in the art at the time of the invention would not have considered it obvious to carry out the Hung process in a medium density plasma reactor.

The dependent claims set forth additional features which further patentably distinguish the claimed process over Hung and Kim.

Claim 10 sets forth that the plasma reactor comprises a dual frequency parallel plate plasma reactor having a showerhead electrode and a bottom electrode, the bottom electrode being supplied RF energy at two different frequencies or the showerhead electrode being supplied RF energy at a lower frequency than the bottom electrode. The Official Action refers to column 3 of Hung for disclosure of a "dual frequency parallel plate plasma reactor" but no such disclosure can be found in Hung. Although Hung refers to a showerhead in the center of the silicon roof 52, there is no suggestion in Hung of a showerhead electrode nor is there any suggestion in Hung of a bottom electrode being supplied RF energy at two different frequencies or supplying a showerhead electrode at a lower frequency than the RF energy supplied to the bottom electrode, as recited in Claim 10. As such, Claim 10 is clearly patentable over Hung taken alone or in combination with Kim.

Claim 21 sets forth that the plasma reactor pressure is at a pressure above 80 mTorr. Hung, on the other hand, discloses a high density plasma reactor wherein the pressure inside the reactor is maintained at low levels such as 5 to 15 mTorr (see Table 6 of Hung). Accordingly, Hung teaches away from the features of Claim 21.

Claim 23 recites that the reactor comprises a capacitively coupled plasma reactor. There is no suggestion in Hung of using a capacitively coupled plasma reactor but rather, Hung discloses use of an inductively coupled plasma reactor which provides a high-density plasma or other high-density plasma reactor such as an ECR reactor (see column 3, lines 23-42 of Hung). Accordingly, Claim 23 is clearly patentable over the combination of Hung and Kim.

It is submitted that the differences between the claimed subject matter and the prior art are such that the claimed subject matter, as a whole, would not have been obvious at the time the invention was made to a person having ordinary skill in the art.

In view of the foregoing, it is submitted that the present application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

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